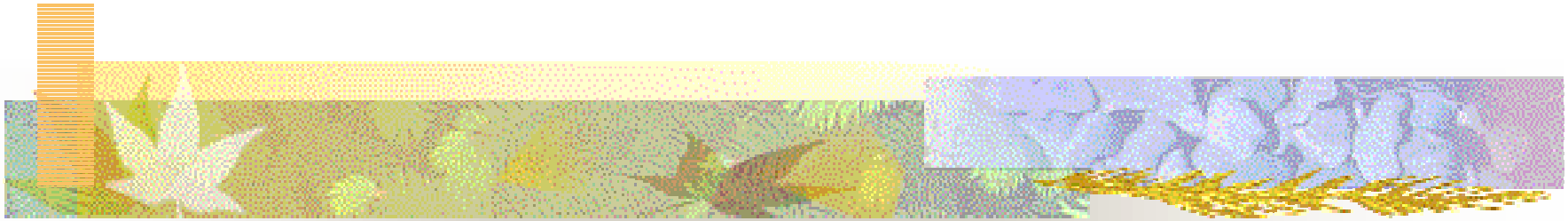
Air Quality Data:
A New Conceptual Approach



Spatial Data Analysis Workshop

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Outline

- Goal
- Present Concept
- New Concept
- Advantages
- Details of Approach
- Approach to Network Design
- Network Design Example
- Next Steps

Basic Goal: Air Quality Data Collection

Produce as complete and accurate a picture (spatial field) of air quality in as cost effective a manner as possible.

Present Concept

- Tenets:
  - Air Quality Data (AQD) are truth
  - If no monitors then no information
- Problems
  - Ignores substantial & relevant information (i.e., Interpolation)
  - Concept is too limited for planning purposes (we must estimate)
  - Therefore we use AQD to create an implicit spatial picture: For Designations - **AQD represent only the county in which they are taken**
  - Disincentive to monitor

New Concept

- Tenets:
  - Measured or interpolated data are the same except for uncertainty – They are an estimate of the actual field
  - Define Air quality as an estimated field of concentrations with associated uncertainties
- Estimate Concentration Field:
  - Recognize that AQD are simply a sample of the "Actual" air quality FIELD
  - Then, estimate the complete field by interpolating (kriging) the AQD
- Estimate an associated uncertainty field based on area modeling

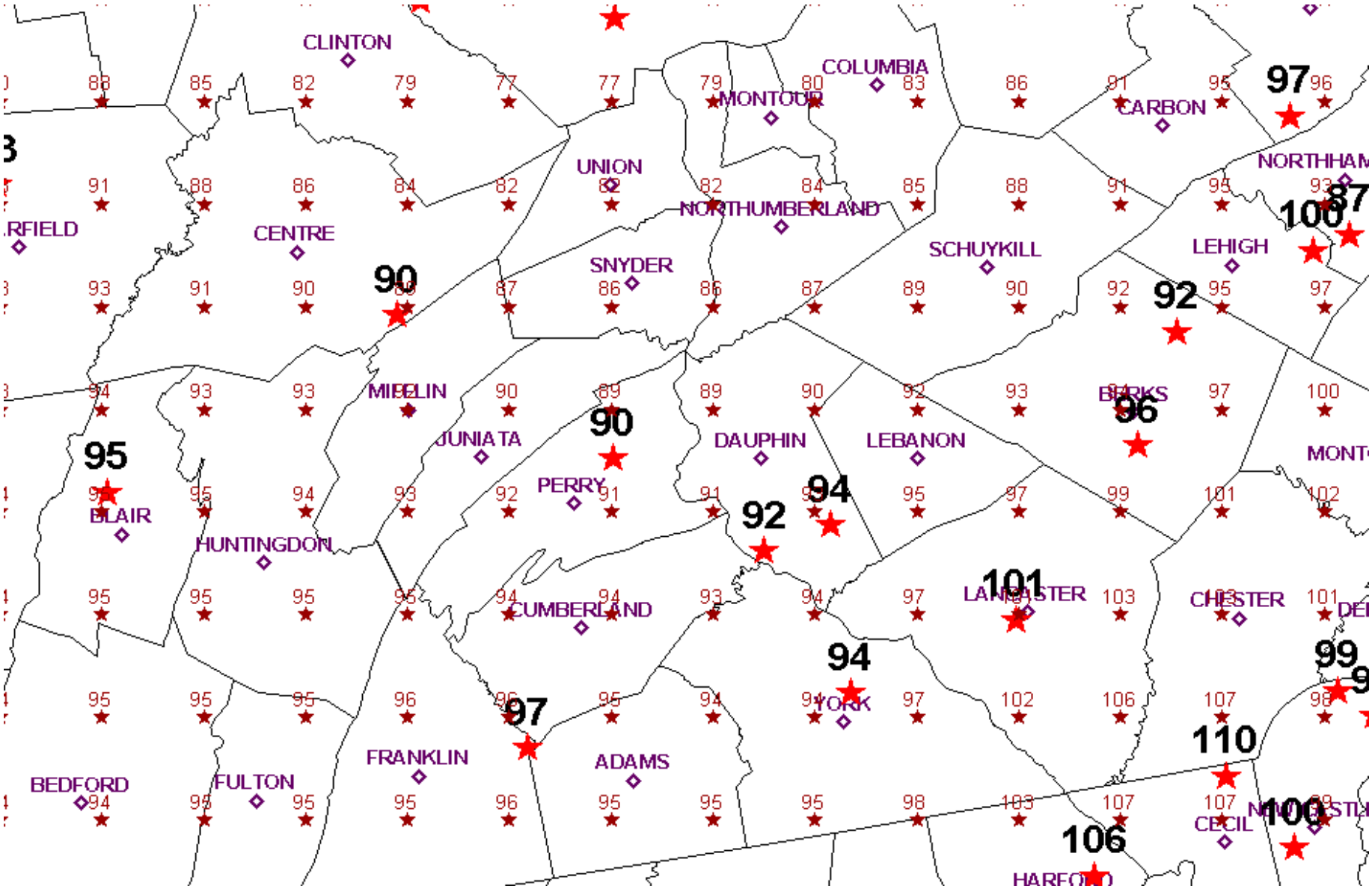
Advantages to New Concept

- A complete field of air quality is available for policy development, trends analysis, etc.
- Robust: Changes to an optimized network should not significantly affect the estimated field
- Removes monitoring disincentive
- Provides a direct blueprint for developing cost-effective networks

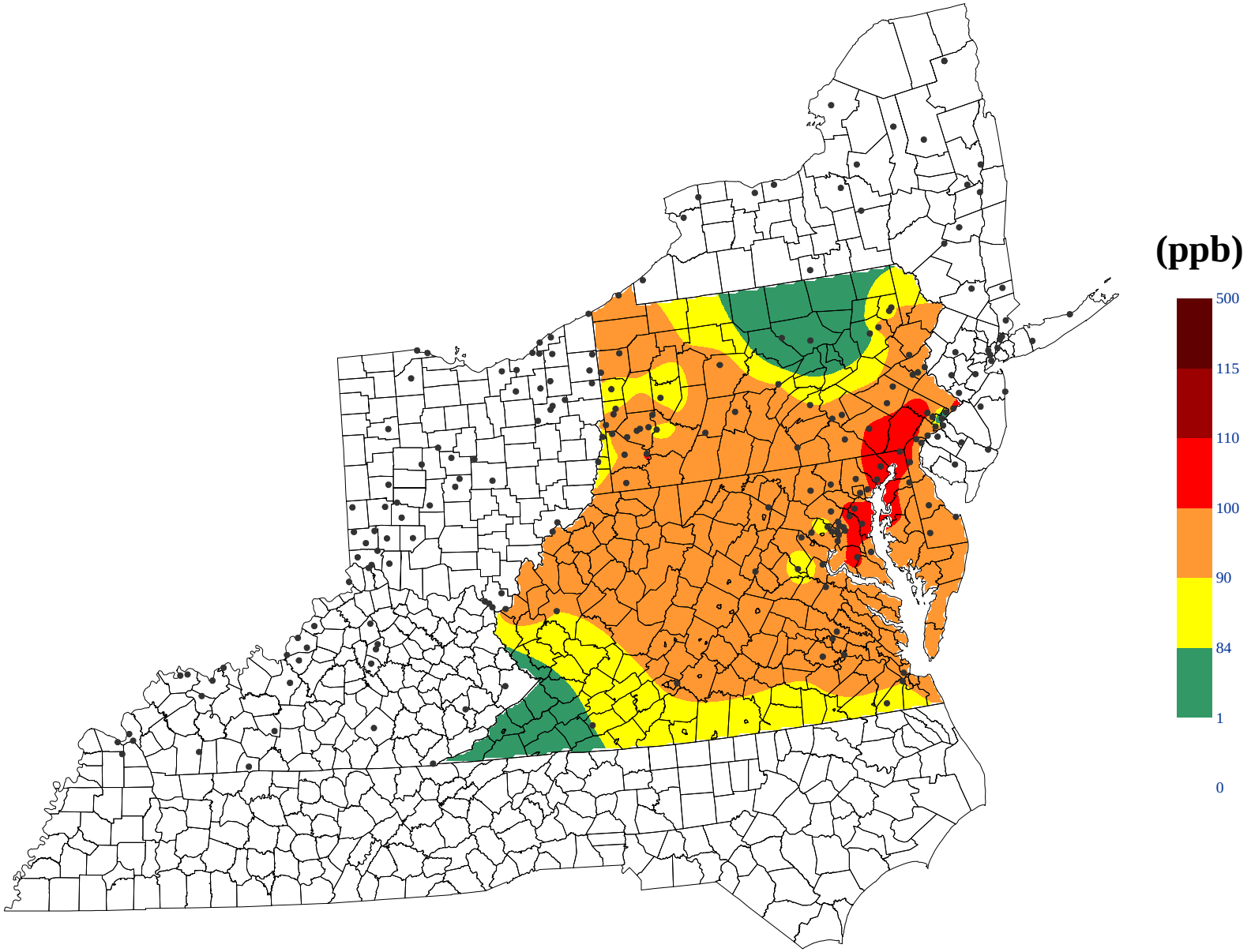
Constructing Concentration Fields

- Establish the best variogram model for the concentration field base on:
  - Air quality data
  - BENCHMARK concentration field from area modeling (modeling data must adequately characterize important features of the field)
- Estimate, through kriging, the actual concentration field using:
  - The optimized variogram model
  - All available monitored air quality values both within and outside the area

1999 8hr. Ozone Design Value:
Kriged Grid (Linear Variogram) with Network Overlay



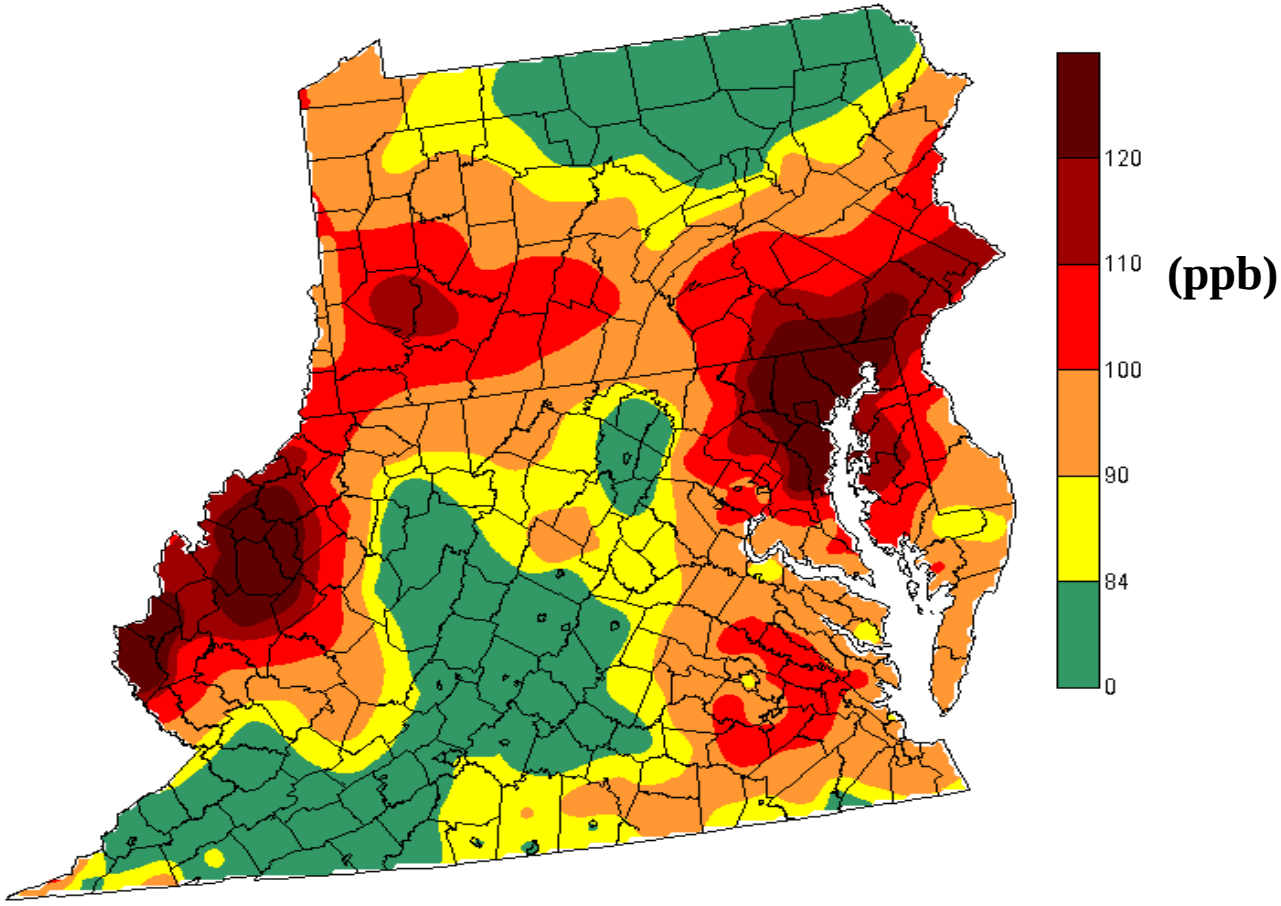
1999 8 hr. Ozone Design Values:
Kriged Contour Map (Linear Variogram)



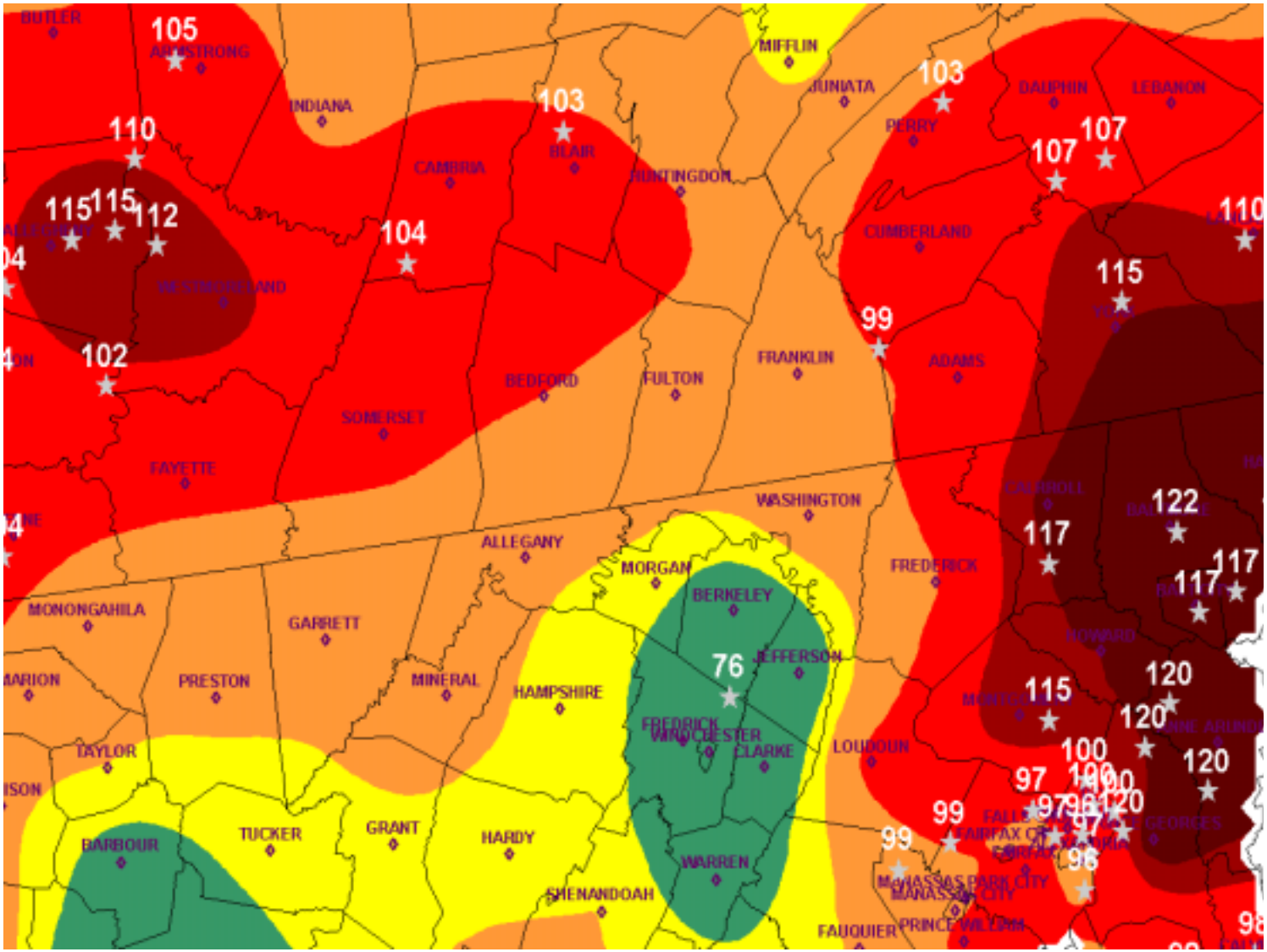
Constructing Uncertainty Fields

- Develop a subset of the benchmark (photochemical dispersion modeled) data based on network monitor locations only
- Estimate the full benchmark concentration field by kriging the benchmark data subset
- Compare the full benchmark field with the estimated field from the benchmark subset
- Construct a field of residuals (the uncertainty field)

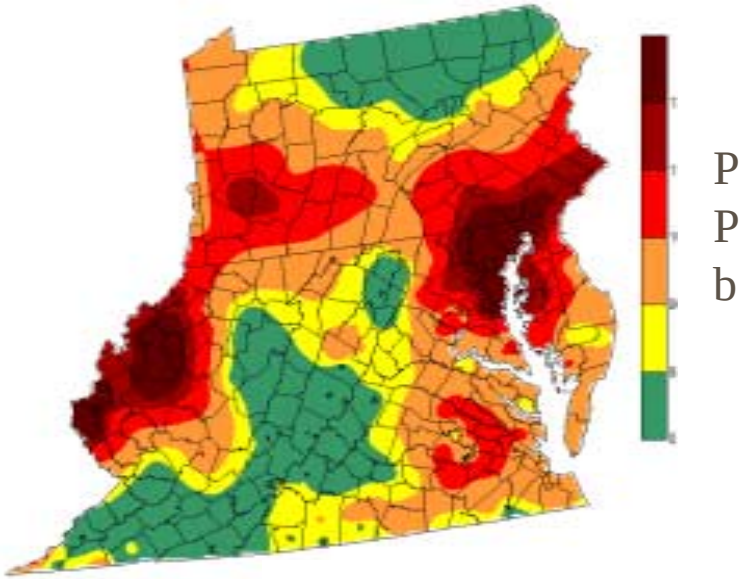
BENCHMARK Data Set
4th High 8hr. Ozone: UAM-V Model Output
1996 Emissions Inventory
30 Days of 1995 Met



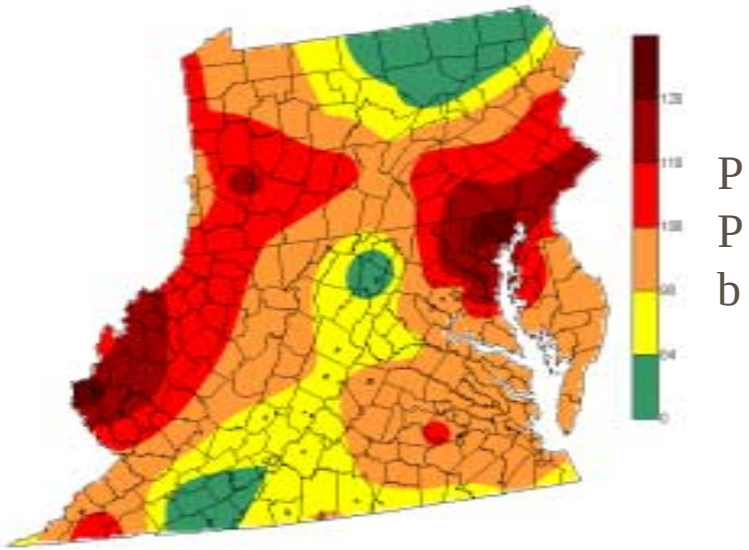
Constructing Data Subset (modeled values at monitor locations) from Benchmark UAM-V Modeling



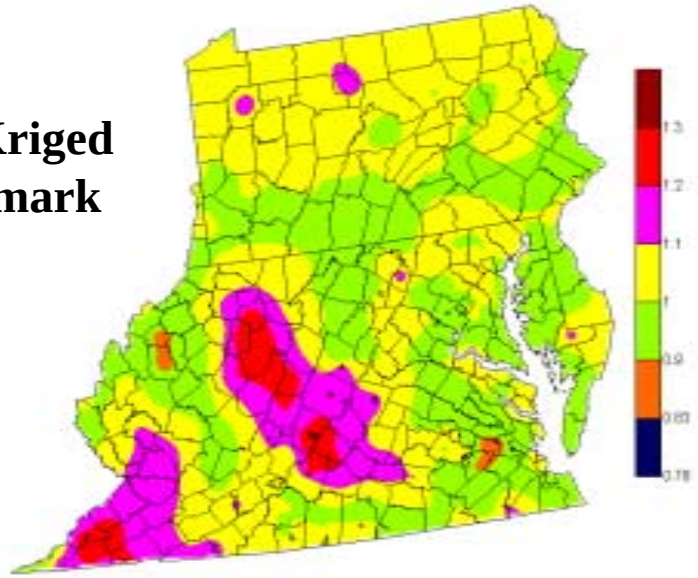
Benchmark Data Set



Kriged Data Sub-Set (1999 O_3 Network)

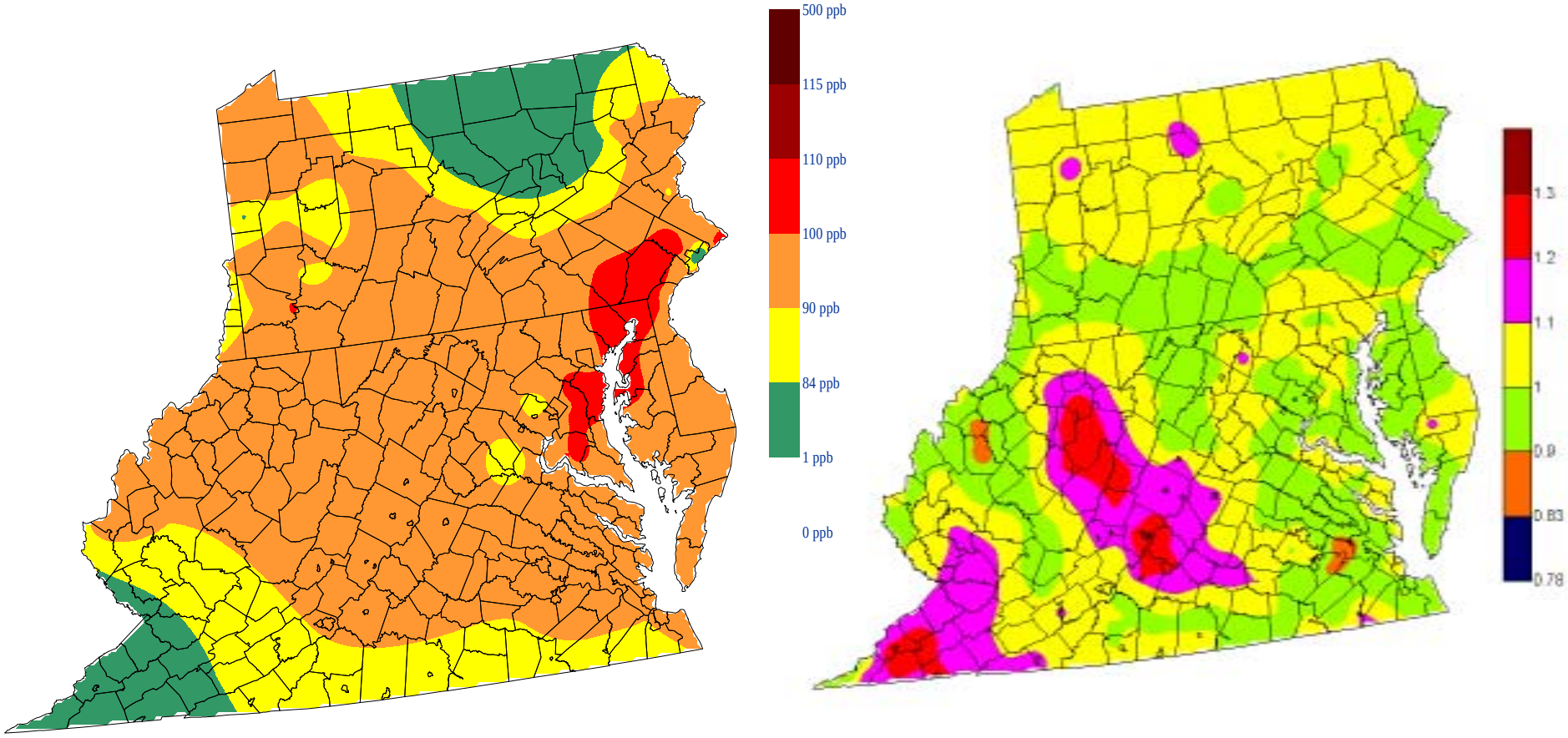


Ratio of Kriged To Benchmark



Air Quality is defined as an interpolated concentration field plus an associated uncertainty field

1999 8hr. DV O_3



Network Design: Premise

The primary purpose of a monitoring network is to estimate a variety of pollutant fields with the lease uncertainty considering resource demands and other appropriate design criteria

Network Design: Approach

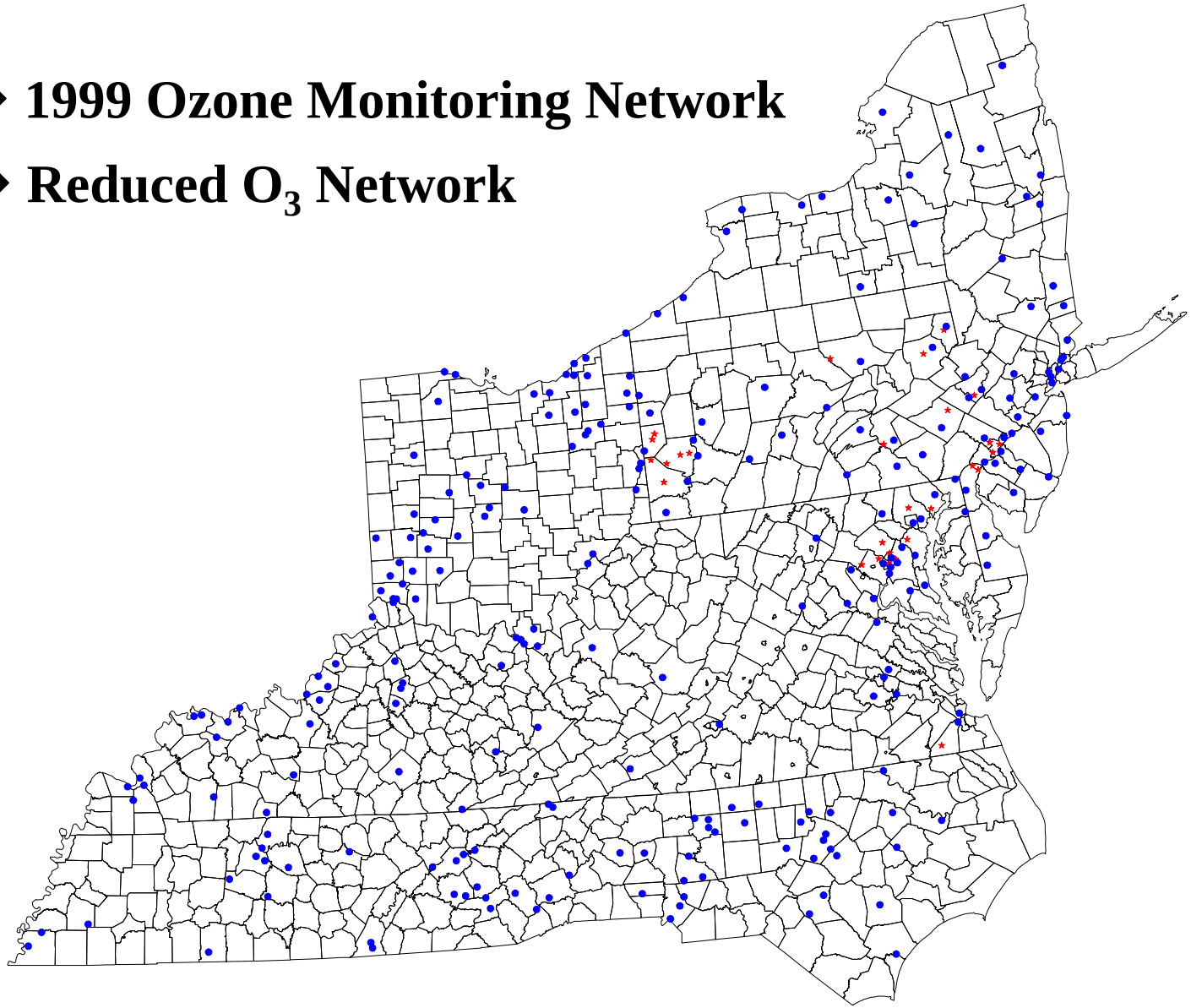
- Develop appropriate benchmark data sets (modeled)
  - Multiple episodes
  - Multiple metrics
  - Multiple pollutants
- Construct potential new network designs (i.e., data subsets from the benchmark field)
- Estimate (krig) concentration fields for each network design
- Develop decision criteria (e.g.):
  - Compare each estimated field to the benchmark fields using statistics such as: Correlation Coefficient; Maximum residual; etc.
  - Multiple areas
  - Resource demand
  - State preference
  - Community preference
  - Other needs: e.g., statutory, trends, PSI, etc.
- Use MIRA to choose design

Network Design: Example

- Consider 4 networks:
  - 1999 O_3 network
  - Reduced network (28 Rg III monitors removed): For counties having multiple monitors, remove all but the one having the max 1999 8 hr. design value
  - Network A: Add 1 monitor to Albemarle, VA
  - Network AH: Add a monitor each to Albemarle, VA & Harrison, WV
- Consider 3 areas:
  - Region 3
  - Region 3's Non-Attainment counties
  - Region 3's Attainment counties
- Consider 1 decision criteria: correlation coefficient

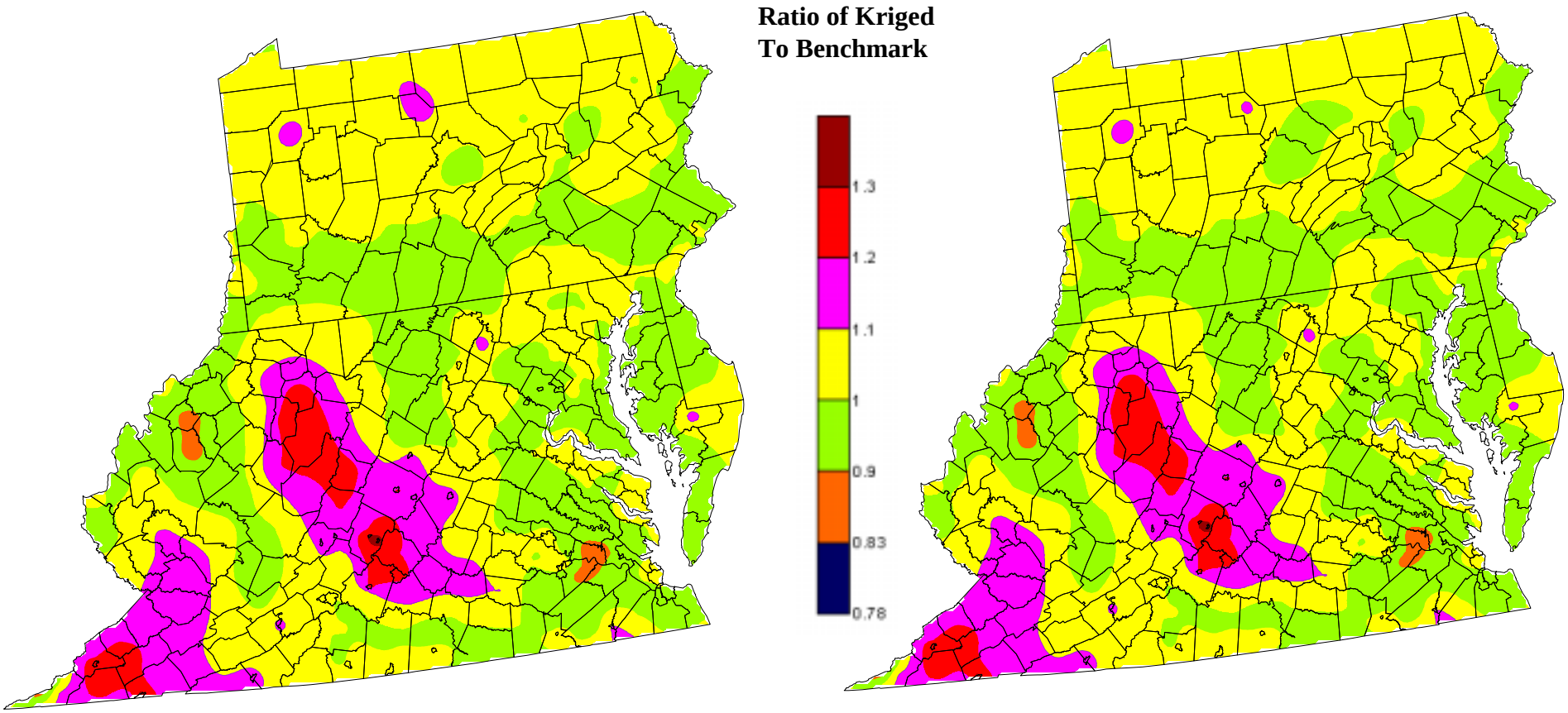
★ + ● ➔ **1999 Ozone Monitoring Network**

● ➔ **Reduced O_3 Network**

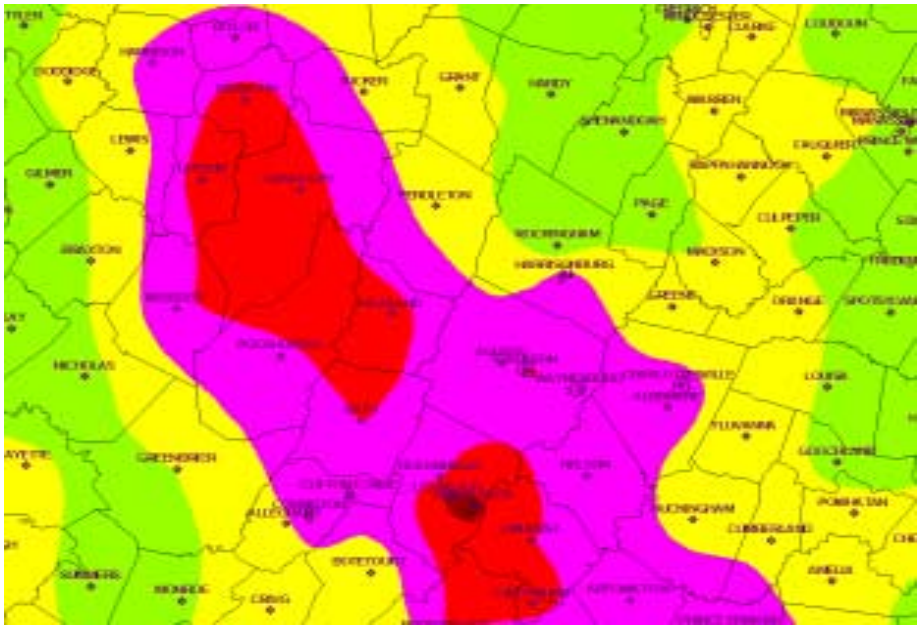


1999 O_3 Network
(Corr Coeff = 0.89)

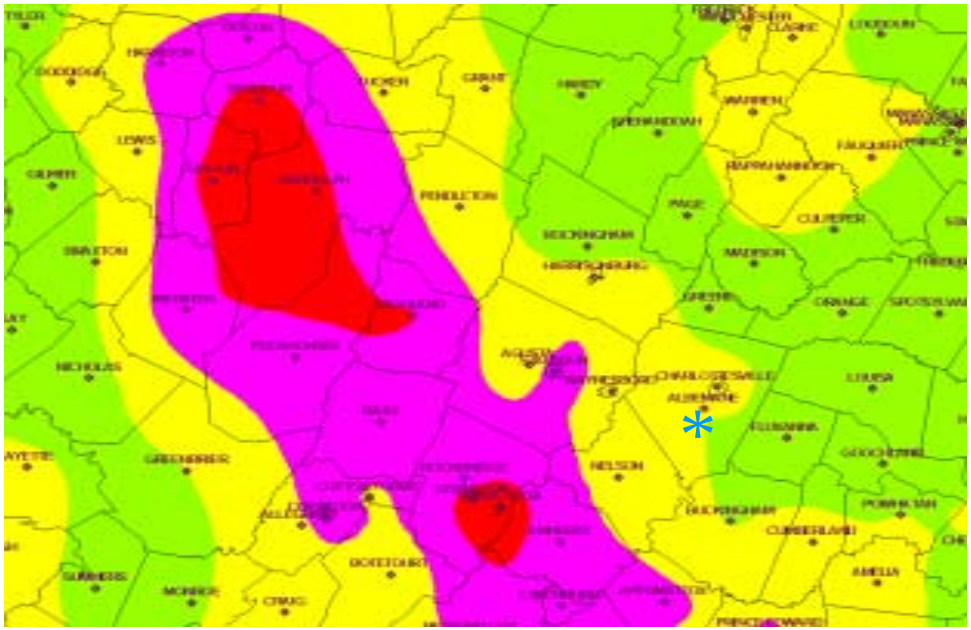
Reduced Network
(Corr Coeff = 0.88)



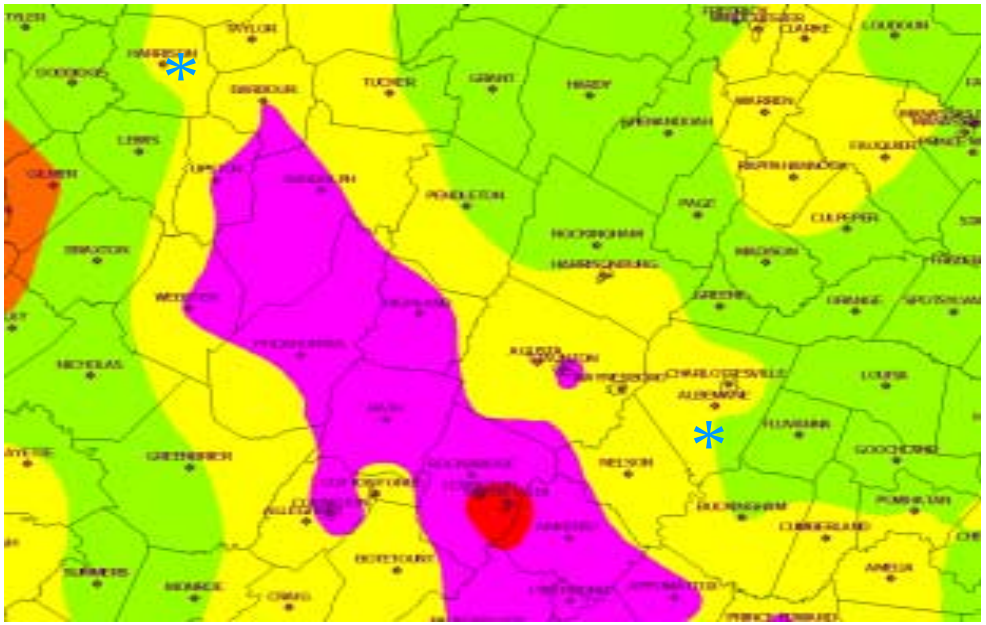
1999 O_3 Network (Corr Coeff = 0.89)



Network A (Corr Coeff = 0.90)



Network AH
(Corr Coeff = 0.91)



Ratio of Kriged To Benchmark

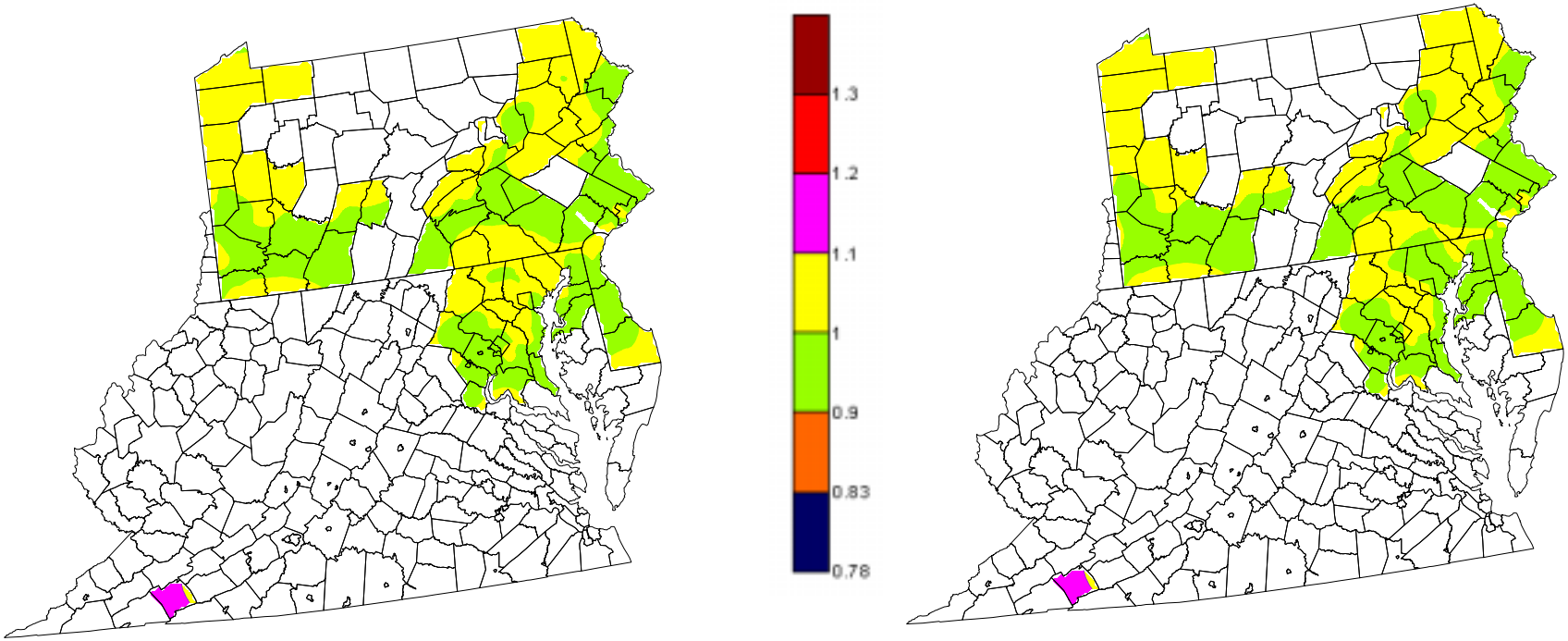
1999 O_3 Network 1 hr. Non-Attn. Areas

(Corr Coeff = 0.97)

Reduced Network 1 hr. Non-Attn. Areas

(Corr Coeff = 0.97)

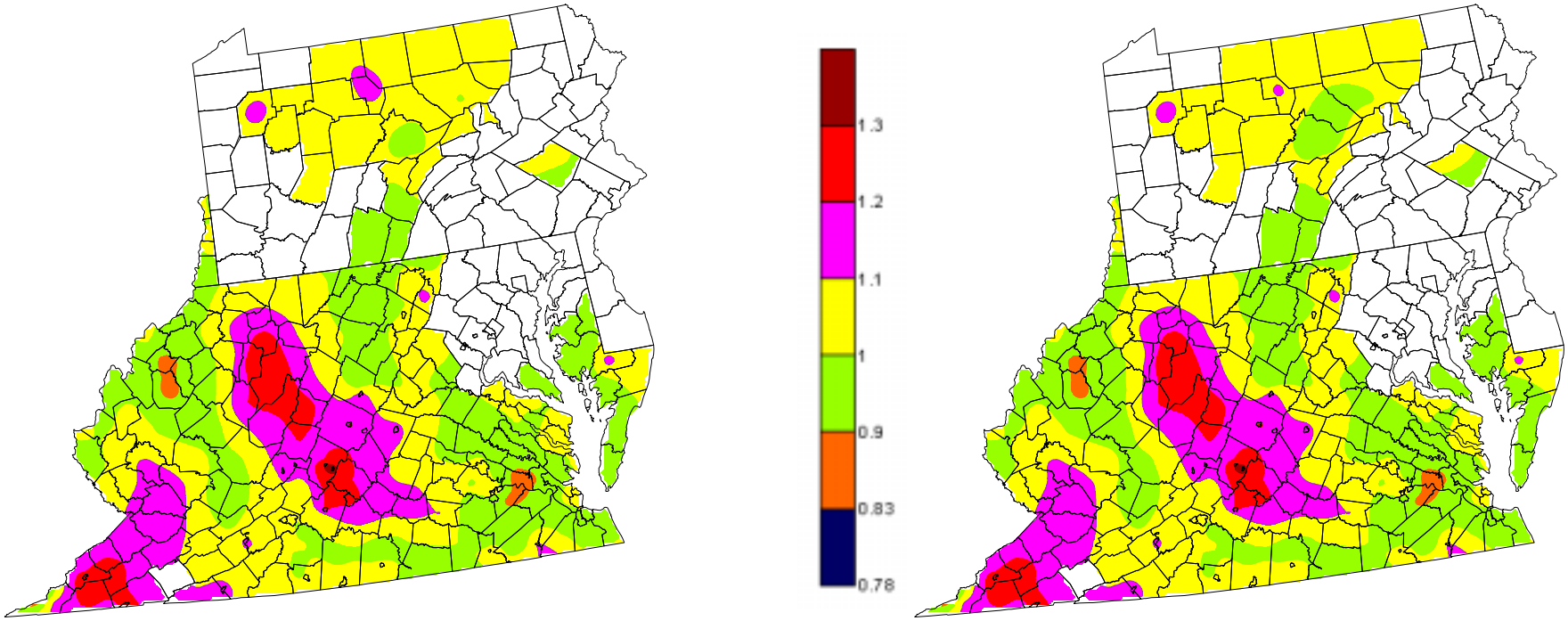
Ratio of Kriged To Benchmark



1999 O_3 Network
1 hr. Attn. Areas
(Corr Coeff = 0.82)

Reduced Network
1 hr. Attn. Areas
(Corr Coeff = 0.82)

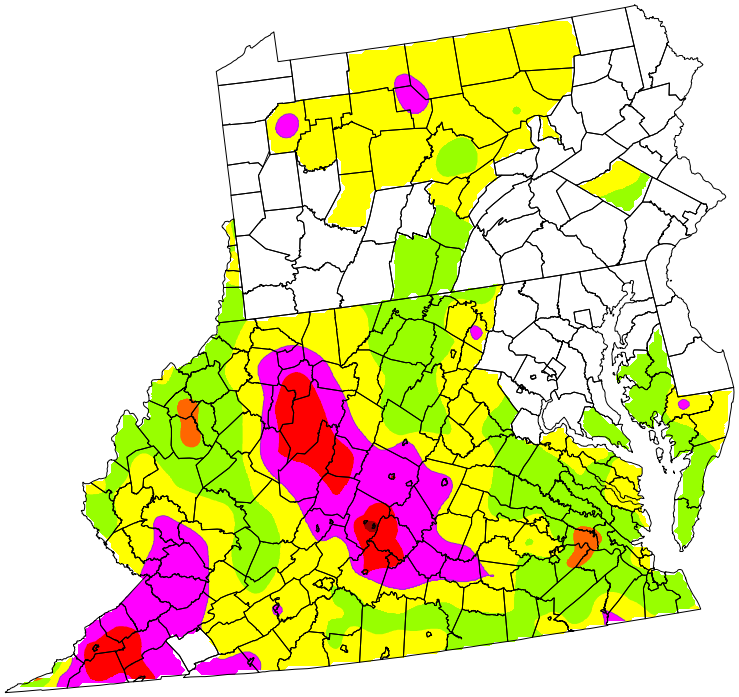
Ratio of Kriged
To Benchmark

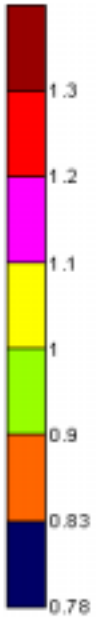


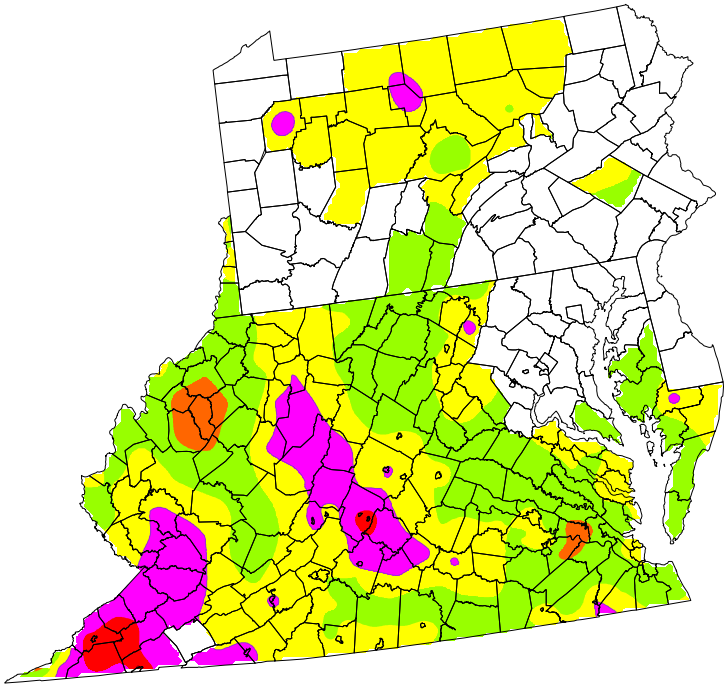
1999 O_3 Network
1 hr. Attn. Areas
(Corr Coeff = 0.82)

Network AH
1 hr. Attn. Areas
(Corr Coeff = 0.86)

Ratio of Kriged
To Benchmark







Next Steps

- Optimized variogram model
- Proceed w/ network reassessment
  - Establish set of benchmark data sets:
    - Additional episodes
    - Additional metrics
  - Decide on comparison statistics
  - Establish other criteria
- Apply new concept to O_3 and $PM_{2.5}$ non-attainment designations – i.e., for counties wo/ monitors use interpolated data.
- Convince DECISION MAKERS to change their view